IR NO. 69-28

INFORMAL REPORT

SUBMARINE SEDIMENT INVESTIGATION IN THE VICINITY OF THE PLANNED SEALAB III HABITAT

JULY 1969

NAVAL OCEANOGRAPHIC OFFICE
WASHINGTON, D. C. 20390

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INFORMAL REPORT

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ABSTRACT

A preliminary investigation of the surficial sediments at the SEALAB III Test Site shows the textural, compositional, and engineering properties to be uniform in both makeup and distribution. Sands and silty sands are the dominant textural grade. Mean diameters range from 0.09 to 0.25 mm. Carbonate content ranges from 55 to 78 percent. The carbonate is in the form of biogenic calcite. Detrital silicates (feldspars, quartz, illite, and chlorite) and minor amounts of organic matter are the remaining constituents present. Wet unit weights and water contents (percent dry weight) on individual samples range from 1.56 to 1.71 g/cm^3 and from 45 to 77 percent, respectively.

Direct shear tests were performed on a prepared sediment sample to determine the range of angles of internal friction. These tests yielded friction angles ranging from $\phi_{min} = 39°$ to $\phi_{max} = 47°$. Because the measured dry unit weight in the shear box was greater than the computed value from volume, weight, and water-content measurements on cores, a minimum friction angle of $\phi_{min} = 29°$ was determined by extrapolation. This latter value was used in the example for determining the ultimate bearing capacity of the sediment.

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INTRODUCTION

The U. S. Navy's SEALAB III program represents an interdisciplinary effort to determine the ability of man to perform useful work on the ocean floor. Tasks of Navy divers and civilian scientists includes work in the following problem areas: studies in diving physiology; evaluation of diving equipment; experiments in salvage and construction techniques; and research in biological, physical, and geological oceanography.

Prior to the placement of SEALAB III on the ocean floor, an investigation was conducted in the proposed habitat area -- from Wilson's Cove, San Clemente Island, seaward to a depth of about 125 fathoms -- for the purpose of making a preliminary study of the sediments on the basis of selected textural, compositional, and engineering properties. Presented herein are the results of the laboratory testing program for: grain size, carbonate content, water content, wet unit weight, and specific gravity of solids. Results of direct shear tests and X-ray diffraction measurements made on selected samples are included in this report. Currents measured in the habitat area will be discussed in a future report.

SETTING

San Clemente Island is the most southern of a group of islands known as the Channel Islands, which are located off the coast of Southern California (Figure 1). The island is about 40 miles south of Santa Catalina Island and approximately 80 miles slightly north of west from San Diego. The center of the island is located at about 32°55'N latitude and 118°30'W longitude.

Previous investigations of the geology of San Clemente have been reported by Smith (1898). More recently, a geologic reconnaissance was performed by Olmsted (1958). Information pertaining to the geology and oceanography of the general area is also available in a book by Emery (1960).

Olmsted (1958) reports that the island is a gently arched and faulted block composed mainly of volcanic rocks of probably Miocene age. Marine sedimentary rocks and unconsolidated sediments, which range in age from Miocene to Recent, are also present on the island. The volcanic rocks are primarily lava flows and associated pyroclastics. These rocks are mainly andesitic, but range in composition from andesite or basaltic andesite to rhyodacite or rhyolite. The marine sedimentary rocks of probable Miocene age overlie or are interbedded with the upper part of the volcanic sequence. They are predominantly thin-bedded siltstones, shales, diatomites, limestones,

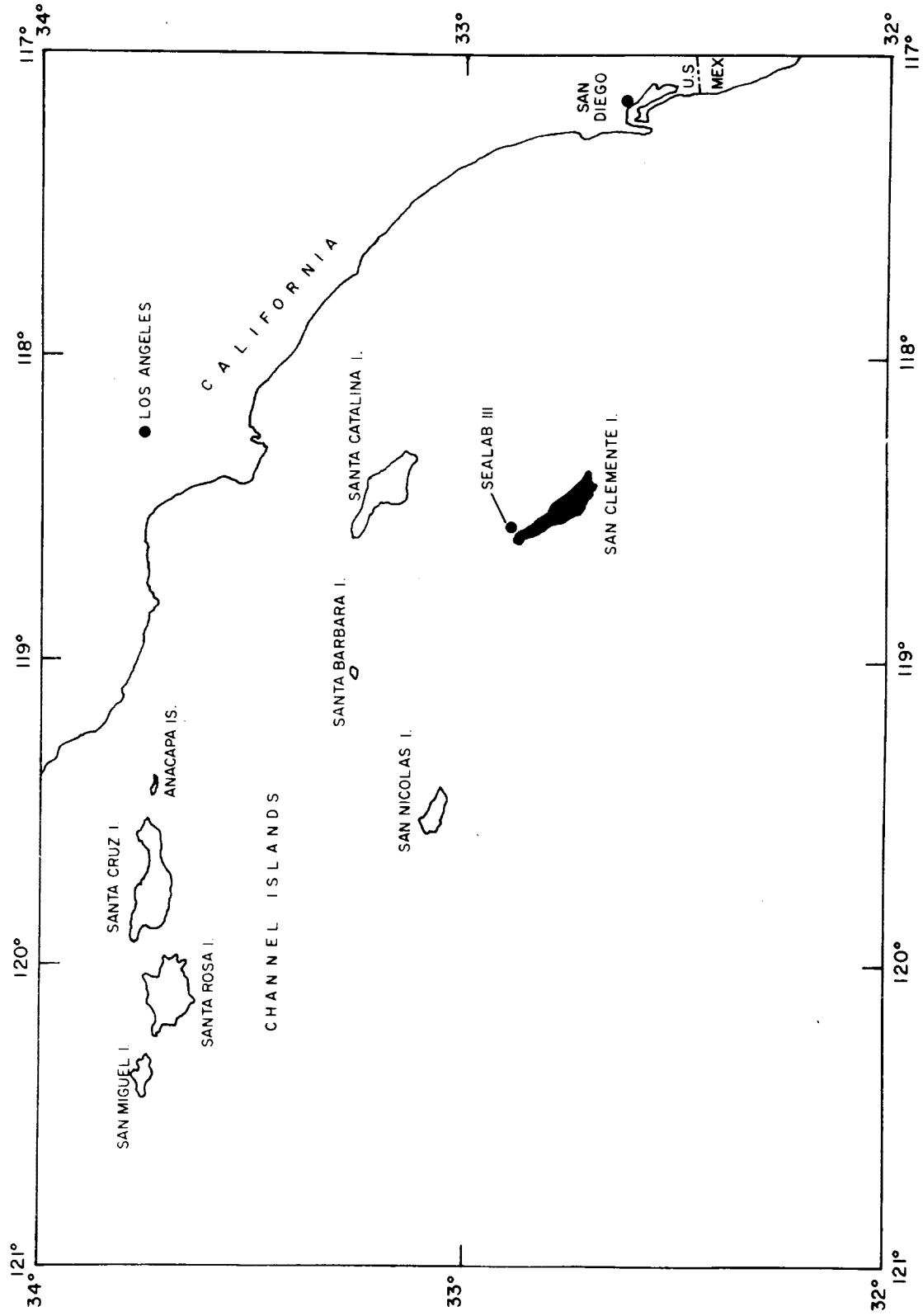


FIGURE 1. LOCATION OF STUDY AREA

and basal sandstones composed of volcanic detritus. Olmsted (1958) defines three Quaternary deposits on the island: "older sand deposits" of Pleistocene age, "younger sand deposits" of Recent age, and "alluvial-fan deposits". Deposits of Pleistocene age are composed of sand with interbedded silts and clays all of which are weathered and are locally cemented with calcium carbonate. The younger sand deposits are well-sorted, loose windblown sand. The alluvial-fan deposits are ill-sorted masses of gravel, sand, and silt. The marine sedimentary rocks are the dominant sedimentary material in the vicinity of Wilson's Cove.

FIELD WORK

A construction barge (CB-2) and a torpedo recovery boat (TRB-12) were used as platforms for collecting sediment samples for this investigation. Sample positions were determined by triangulation from two towers on San Clemente Island (Table I) and are plotted on a bathymetric chart (Figure 2) provided by the Naval Ordnance Test Station, Pasadena, California.

Initial coring work was performed with a Hydroplastic corer (Richards and Keller, 1961). Because of the lack of penetration with this corer, a modified Kullenberg gravity corer was used for all subsequent coring work. A Shipek sampler was used for obtaining grab samples. All sediment samples were collected in accordance with standard oceanographic procedures (U. S. Navy Hydrographic Office, 1955).

LABORATORY WORK

Water content (percent dry weight), w, and wet unit weight, γ_m, were performed at San Clemente Island to reduce sample disturbance and desiccation (Richards, 1961). The original work plan was to include laboratory vane shear tests, but this plan was changed because the materials obtained were predominatly cohesionless sediments. The principal strength parameter for cohesionless sediments is the angle of internal friction, ϕ , which is not defined by the vane shear test. For this reason, direct shear tests were added to the testing schedule (Lambe, 1951).

Textural, compositional, and shear strength analyses were performed at the U. S. Naval Oceanographic Office. Definitions of textural and compositional terms not in the text of this report may be found in the sediment size computer program developed by Rucker and Stewart (1966). Terminology concerning engineering properties (or mass properties) may be found in reports by Stiles (1967) and Kessler and Stiles (1968). Sediment data in this report, unless otherwise stated, represents the interval from 0 to 10 centimeters beneath the water-sediment interface.

TABLE I

SAMPLE LOCATIONS

SAMPLE[1/] NO.	LAMBERT COORDINATES		GEOGRAPHIC COORDINATES		SAMPLE LENGTH cm
1	N 309 856.72	E 1 299 368.40	33° 00' 10.12" N	118° 32' 06.93" W	36
2	N 310 305.39	E 1 299 244.80	33° 00' 05.70" N	118° 32' 08.49" W	NR[2/]
3	N 310 281.72	E 1 299 752.00	33° 00' 05.83" N	118° 32' 02.53" W	NR
4	N 310 765.56	E 1 299 222.90	33° 00' 01.16" N	118° 32' 08.87" W	NR
5	N 310 702.23	E 1 299 098.30	33° 00' 01.81" N	118° 32' 10.32" W	NR
6	N 310 726.80	E 1 299 258.20	33° 00' 01.53" N	118° 32' 08.45" W	33
7	N 310 397.71	E 1 299 094.30	33° 00' 04.83" N	118° 32' 10.28" W	20
8	N 310 749.14	E 1 298 163.20	33° 00' 01.55" N	118° 32' 21.31" W	94
9	N 310 998.29	E 1 298 419.80	33° 01' 59.03" N	118° 32' 18.36" W	23
10	N 311 011.63	E 1 298 613.40	33° 01' 58.85" N	118° 32' 16.09" W	80
11	N 309 964.76	E 1 299 770.00	33° 00' 08.96" N	118° 32' 02.16" W	20
12	N 310 356.28	E 1 299 255.60	33° 00' 05.20" N	118° 32' 08.38" W	15
13	N 310 283.17	E 1 298 458.80	33° 00' 06.10" N	118° 32' 17.72" W	NR
14	N 309 714.65	E 1 299 466.90	33° 00' 11.50" N	118° 32' 05.74" W	NR
15	N 310 722.14	E 1 298 880.40	33° 00' 01.66" N	118° 32' 12.88" W	NR
16	N 310 813.81	E 1 299 022.90	33° 00' 00.72" N	118° 32' 11.23" W	NR
17	N 310 434.32	E 1 299 215.90	33° 00' 04.43" N	118° 32' 08.87" W	NR
18	N 310 290.59	E 1 299 078.30	33° 00' 05.89" N	118° 32' 10.45" W	NR
19	N 309 644.80	E 1 299 110.70	33° 00' 12.27" N	118° 32' 09.90" W	10
20	N 310 360.09	E 1 299 699.40	33° 00' 05.06" N	118° 32' 03.17" W	10
21	N 310 372.10	E 1 300 047.90	33° 00' 04.87" N	118° 31' 59.08" W	10
22	N 311 167.77	E 1 299 992.40	33° 01' 57.01" N	118° 31' 59.94" W	10
23	N 311 495.32	E 1 299 932.10	33° 01' 53.78" N	118° 32' 00.73" W	NR
24	N 311 027.67	E 1 300 261.10	33° 01' 58.34" N	118° 31' 56.75" W	Rock
25	N 311 142.54	E 1 299 639.00	33° 01' 57.34" N	118° 32' 04.88" W	10

1/ Core Samples 1-16 and Grab Samples 17-25

2/ NR - No Recovery

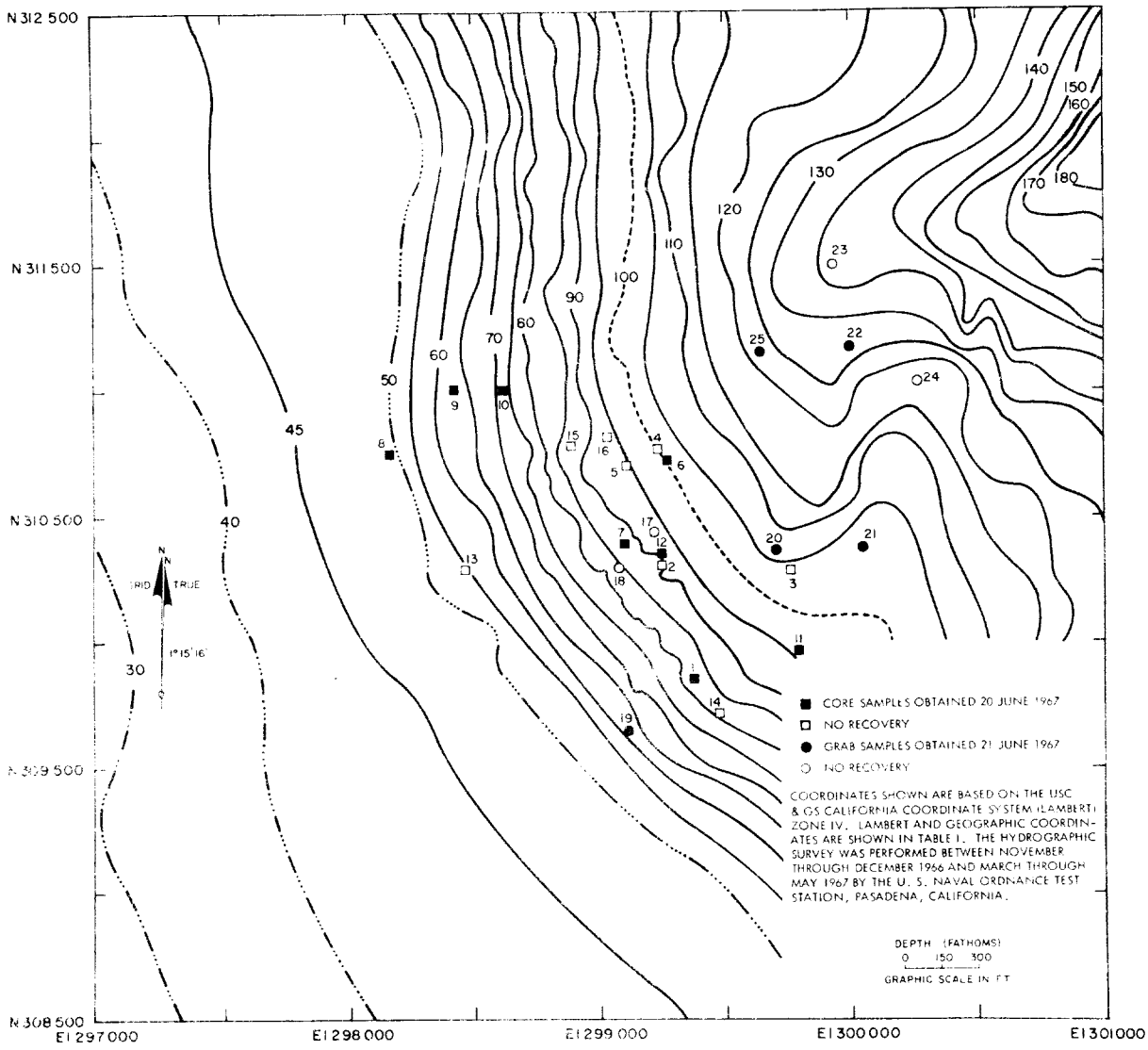


FIGURE 2. SEALAB III SITE BATHYMETRY, SAN CLEMENTE ISLAND TEST RANGE

Grain-size analyses were performed according to standard procedures outlined by Krumbein and Pettijohn (1938). Representative specimens were wet sieved with a dilute sodium hexametaphosphate solution through a 0.062 mm sieve. The fraction retained on the sieve was then ovendried and resieved through a nested set of sieves with meshes ranging from 2.00 mm to 0.062 mm. The fine fraction was pipetted at Wentworth (1922) size intervals.

Carbonate content was determined by treating the sample with dilute hydrochloric acid, filtering the solution, washing and drying the residue, and computing the percent insoluble residue (Twenhofel and Tyler, 1941).

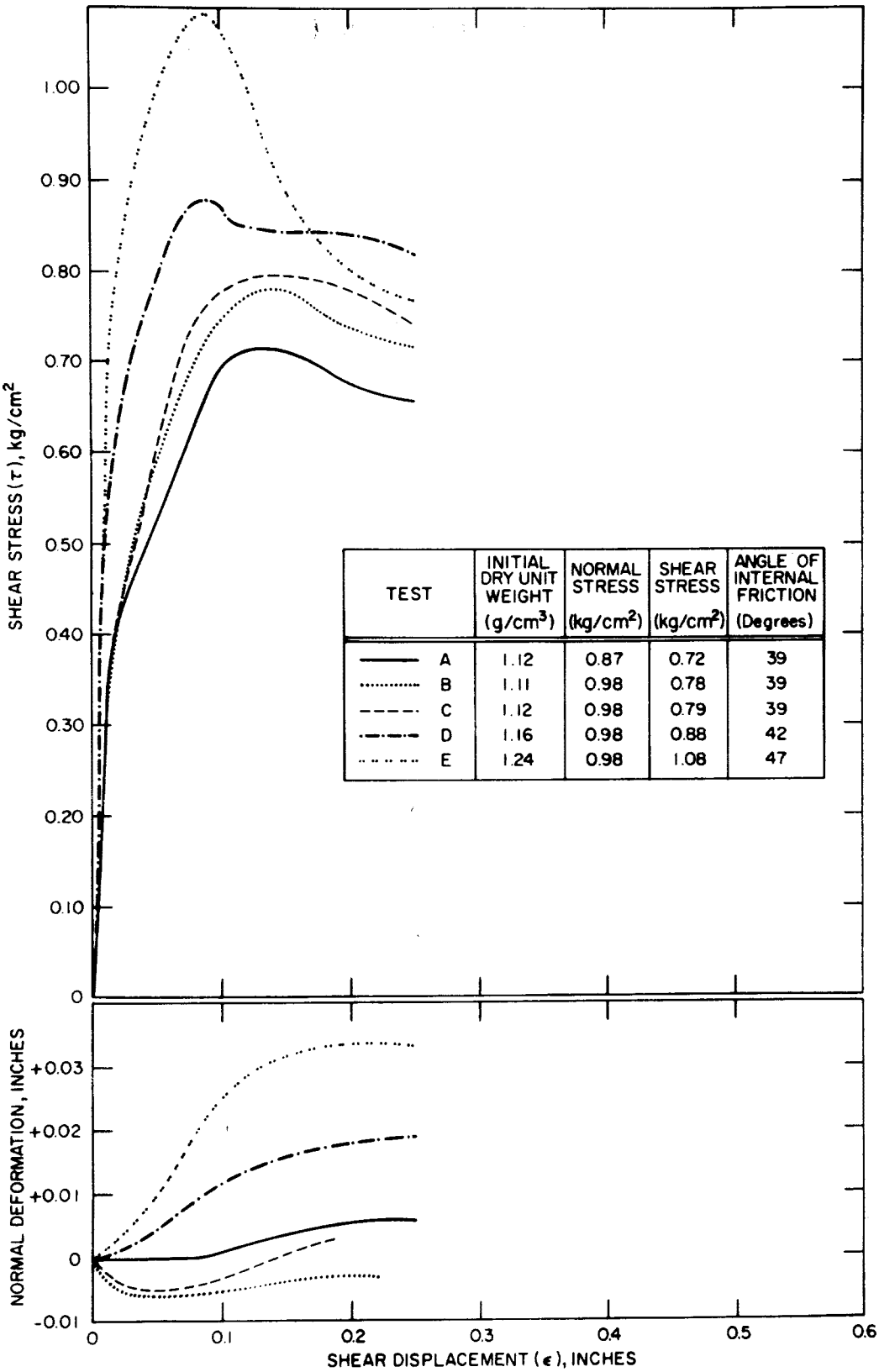
Standard X-ray diffraction techniques were used to determine the mineral content. Organic matter was determined by computing the percent insoluble residue after leaching the sediment with a concentrated hydrogen peroxide solution.

Direct shear, specific gravity of solids, and dry unit weight measurements were made on a prepared sample consisting of combined, air dried, and split portions of grab samples 20, 21, and 25. To determine the range of angles of internal friction for this prepared sediment sample, direct shear tests were performed at maximum and minimum dry unit weights. Maximum dry unit weight was attained by tamping and vibrating the sediment in the shear box prior to shear. Minimum values were attempted by slowly pouring the loose sediment through a funnel into the shear box prior to shear. Angles of internal friction were determined from the normal load (normal stress) and the maximum (peak) shear stress values (Figure 3). The rate of shear displacement for all tests was 0.05 in/min.

RESULTS

Textural as well as compositional and engineering properties are for the most part uniform in the study area (Table II). The surficial sediments or the interval between 0 and 10 centimeters beneath the water-sediment interface are sands and silty sands based upon the classification system of Shepard (1954). Except for Sample 11, 67 percent or more of each sample was retained on the 0.062 mm sieve. Mean diameters range from 0.09 mm (Sample 10) to 0.25 mm (Sample 9) with 77 percent of the samples falling between 0.09 and 0.12 mm. Although only one rock (cobble-size) was recovered during the sampling operation, large numbers of cobble- to boulder-size rocks along the shoreline suggest that the study area may contain numerous cobble- to boulder-size rocks. Poor core recovery may be partly due to scattered rock debris.

Standard deviations, which are a measure of sorting, range from 2.07 phi (Sample 20) to 2.74 phi (Samples 11 and 25). Except for Sample 11 in the



TEST	INITIAL DRY UNIT WEIGHT (g/cm^3)	NORMAL STRESS (kg/cm^2)	SHEAR STRESS (kg/cm^2)	ANGLE OF INTERNAL FRICTION (Degrees)
A	1.12	0.87	0.72	39
B	1.11	0.98	0.78	39
C	1.12	0.98	0.79	39
D	1.16	0.98	0.88	42
E	1.24	0.98	1.08	47

FIGURE 3. SHEAR STRESS AND NORMAL DEFORMATION VERSUS SHEAR DISPLACEMENT

TABLE II

SUMMARY OF SEDIMENT DATA

SAMPLE NO.	GRAVEL %	SAND %	SILT %	CLAY %	STANDARD DEVIATION phi	MEAN DIAMETER mm	WET UNIT WEIGHT g/cm^3	WATER CONTENT % dry wt.	SEDIMENT* TYPE	CARBONATE %
1	-	82	13	5	2.11	0.12	1.69**	48**	Sand	59
6	1	73	22	4	2.35	0.12	1.56**	52**	Silty Sand	67
7	-	74	22	4	2.13	0.10	--	45**	Silty Sand	64
8	2	67	25	6	2.52	0.10	1.62**	61**	Silty Sand	72
9	5	79	13	3	2.37	0.25	--	47**	Sand	69
10	1	69	23	7	2.54	0.09	1.60**	63**	Silty Sand	67
11	3	56	33	8	2.74	0.10	--	57**	Silty Sand	55
12	1	71	24	4	2.15	0.12	1.71**	77**	Silty Sand	74
19	1	84	11	4	2.21	0.15	--	68	Sand	66
20	-	78	17	5	2.07	0.10	--	70	Sand	69
21	1	80	15	4	2.12	0.12	--	62	Sand	72
22	4	69	23	4	2.35	0.11	--	68	Silty Sand	67
25	3	76	16	5	2.74	0.19	--	70	Sand	78

* After Shepard (1954)

** Average value in core
(All other values represent the interval from 0 to 10 cm beneath the water-sediment interface)

southeastern portion of the area, standard deviations (2.35 to 2.74) are slightly greater to the north. Values in the southern half of the area range from 2.07 to 2.21 phi. Low values of standard deviation indicate greater sorting of the sediments into single or fewer grade sizes. The sorting action is most likely caused by bottom currents. An examination of the bottom current data from the area shows that although the magnitude is small (about 0.1 knot) and the direction is variable, northwest currents tend to predominate.

Carbonate measurements show little areal variation (Table II). Values range from 55 percent (Sample 11) to 78 percent (Sample 25). Results of X-ray diffraction measurements (Sample 8, 53-60 cm) are shown in Table III. These measurements plus a microscopic examination show that the carbonate is mainly in the form of biogenic calcite. Detrital silicates (feldspars, quartz, illite, and chlorite) and organics make up the secondary constituents.

TABLE III

SEDIMENT COMPOSITION

Sample Fraction	Acid Soluble	Acid Insoluble	
	Carbonate[1/]	Detrital Silicate[2/]	Organic[3/]
Microns	%	%	%
> 37	80	10	10
< 37	30	65	5

1/ Biogenic calcite
2/ Feldspars, quartz, and minor amounts of clay minerals (chlorite and illite)
3/ Oxidized by concentrated hydrogen peroxide

Average wet unit weight, dry unit weight, and water-content values show little change throughout the study area. Values presented in Table II are single measurements (grab samples) or average measurements on cores 1 to 2 feet in length. Wet unit weights range from 1.56 g/cm^3 (Sample 6) to 1.71 g/cm^3 (Sample 12). Water-content values on these same cores range from 52 to 77 percent, respectively. These values correspond to computed dry unit weights of 0.97 g/cm^3 (Sample 12) and 1.03 g/cm^3 (Sample 6).

Direct shear tests were made with the aim of determining the range of the angles of internal friction, ϕ, for the prepared sediment sample previously discussed. Initial dry unit weights as determined in the shear box range from 1.11 g/cm^3 (Test B) to 1.24 g/cm^3 (Test E), as shown in Figure 3. Dry unit

weights as computed from volume, weight, and water-content measurements on the core samples range from 0.97 g/cm^3 (Sample 12) to 1.14 g/cm^3 (Sample 1). Because the dry unit weight determined from Sample 12 was lower than the value determined from the prepared shear box sample, the minimum angle of internal friction ($\phi_{min} = 29°$) was obtained by extrapolation (Figure 4). The maximum angle of internal friction ($\phi_{max} = 47°$) corresponds to the largest measured dry unit weight from the shear box (Test E). Strength envelopes for the maximum and minimum friction angles from the direct shear tests, and the extrapolated minimum friction angle are shown in Figure 5.

CONCLUSIONS

A preliminary investigation of the surficial sediments at the SEALAB III habitat site shows the textural, compositional, and engineering properties to be uniform in both makeup and distribution. Sands and silty sands are the dominant textural grade. Mean diameters range from 0.09 to 0.25 mm. Carbonate content ranges from 55 to 78 percent. The carbonate is in the form of biogenic calcite. Detrital silicates (feldspars, quartz, illite, and chlorite) and minor amounts of organic matter are the remaining constituents present. Wet unit weights and water contents (percent dry weight) on individual samples range from 1.56 to 1.71 g/cm^3 and from 45 to 77 percent, respectively.

Direct shear tests were performed on a prepared sediment sample to determine the range of angles of internal friction. These tests yielded friction angles ranging from $\phi_{min} = 39°$ to $\phi_{max} = 47°$. Because the measured dry unit weight in the shear box was greater than the computed value from volume, weight, and water-content measurements on cores, a minimum friction angle of $\phi_{min} = 29°$ was determined by extrapolation. This latter value was used in the example for determining the ultimate bearing capacity of the sediment.

The above direct shear results on the prepared sediment sample are not sufficient for an overall engineering foundation analysis of the SEALAB III habitat site. However, because some indication of the bearing capacity of the sediments may be helpful for future engineering work, an example is presented in the Appendix showing the steps and calculations involved with one method for determining the ultimate bearing capacity of terrestrial soils.

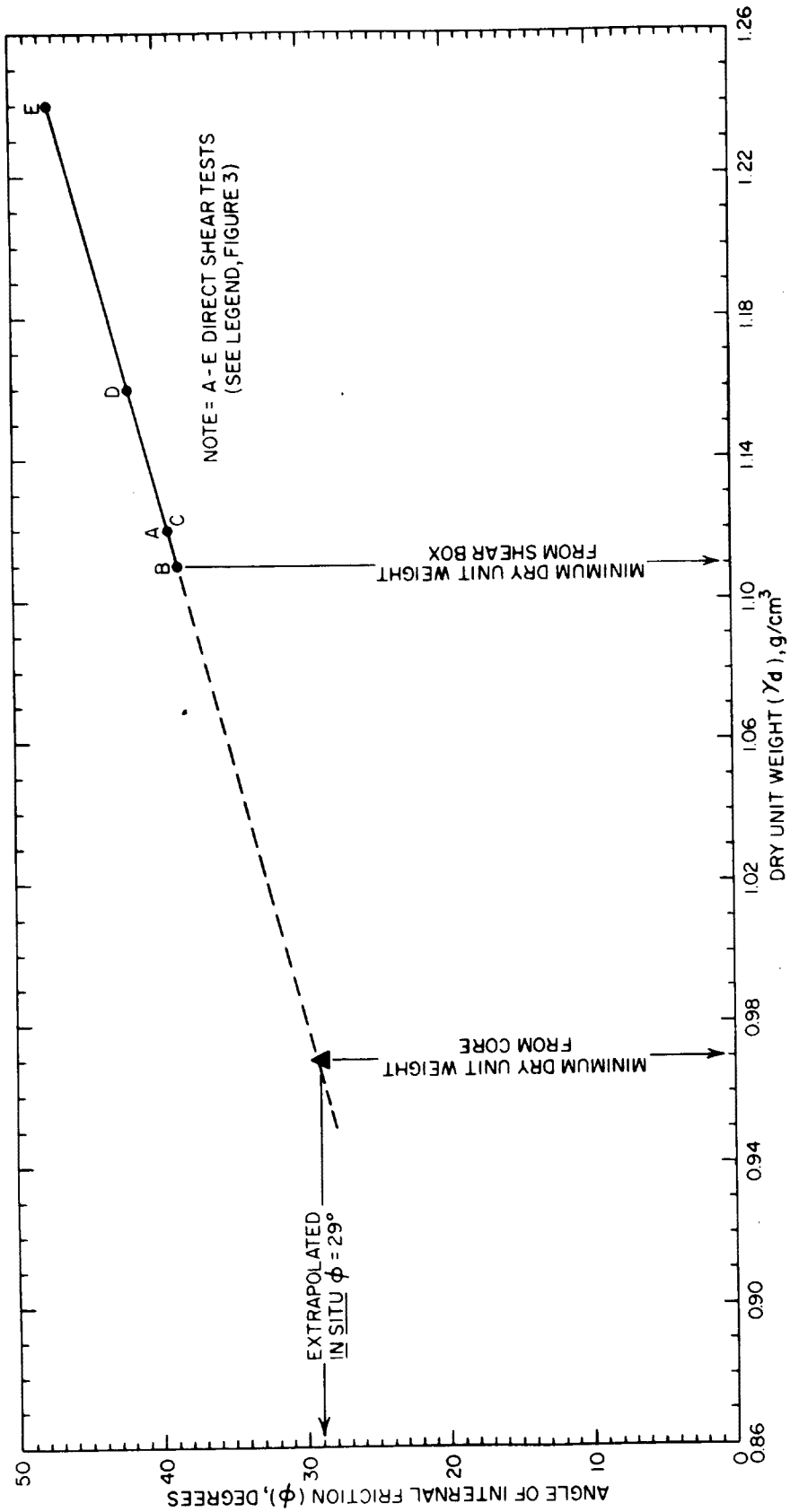


FIGURE 4. ANGLE OF INTERNAL FRICTION VERSUS DRY UNIT WEIGHT

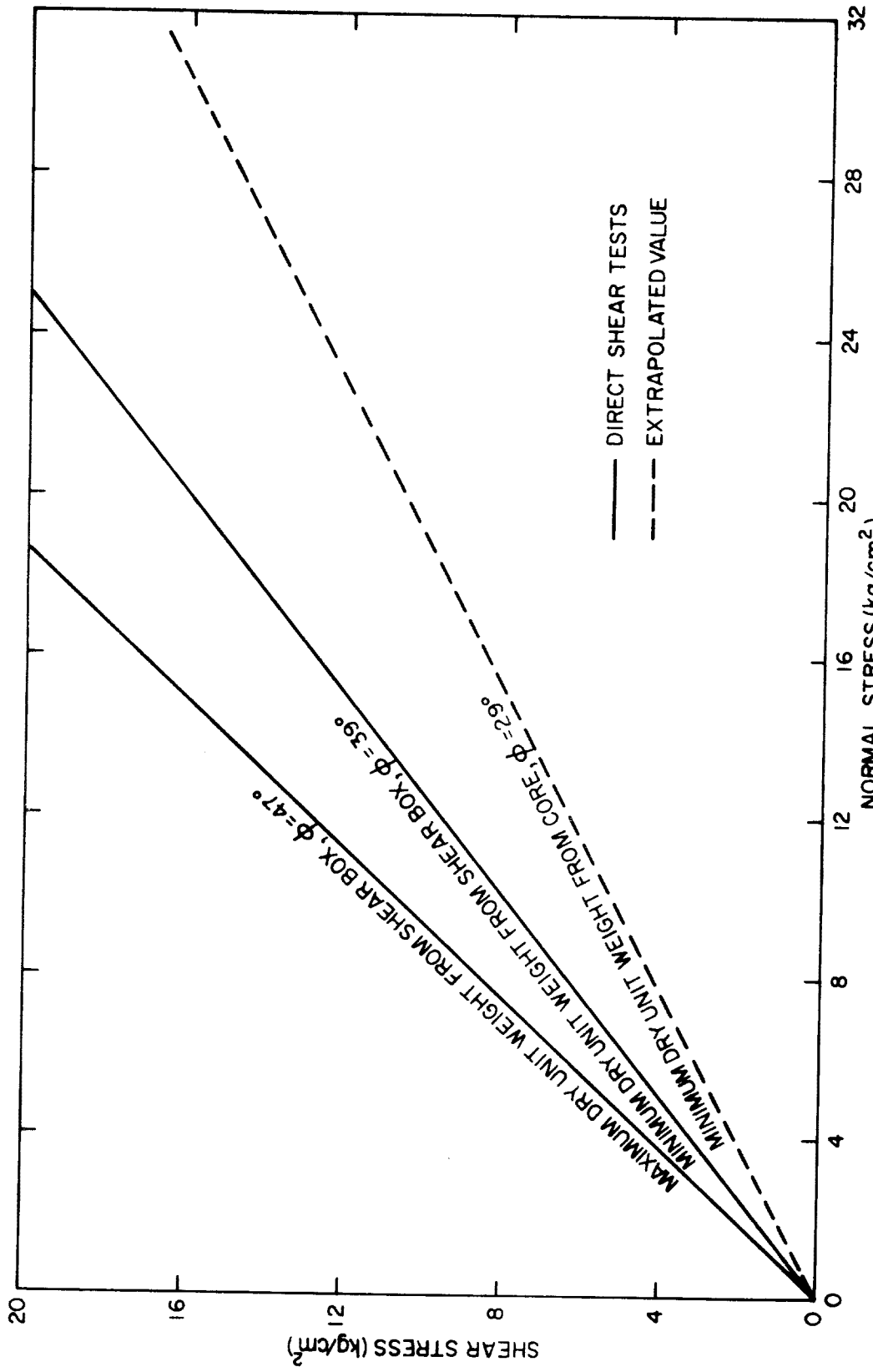


FIGURE 5. STRENGTH ENVELOPES

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APPENDIX A

EXAMPLE OF A BEARING CAPACITY CALCULATION

Using the minimum-measured in-place dry unit weight (γ_d) of 0.97 g/cm^3, the unit weight of water (γ_w) equal to 1.00 g/cm^3, and a specific gravity (G_s) of 2.68, a void ratio (e) may be calculated,

$$e = \frac{G_s \gamma_w}{\gamma_d} - 1 \qquad (1)$$

$$e = 1.76$$

Assuming that the sediment mass is completely saturated and is therefore in a buoyant state, the buoyant unit weight (γ_b) is,

$$\gamma_b = \frac{G_s - 1}{1 + e} \gamma_w \qquad (2)$$

$$\gamma_b = 0.61 \text{ g/cm}^3$$

Assume that the clump or foundation resting on the bottom has a square configuration of width equal to 5 meters. Now, entering Figure 4 with a dry unit weight of 0.97 g/cm^3, an angle of internal friction (ϕ) of 29° is determined.

The equation for ultimate bearing capacity of a square footing, failing in local shear will be used for this example (Terzaghi and Peck, 1967). The general equation for the above conditions is,

$$q'_u = 1.2(2c/3)\ N'_c + \gamma D_f N'_q + 0.4 \gamma B N'_\gamma \qquad (3)$$

where

q'_u = ultimate bearing capacity, g/cm^2

B = width of clump or foundation, cm

c = cohesion, g/cm^2

γ = unit weight of sediment, g/cm^3

D_f = depth of embedment, cm

N'_γ, N'_c, N'_q = bearing capacity factors for local shear

The cohesion and depth of embedment are assumed to be zero and equation (3) reduces to,

$$q'_U = 0.4(\gamma B N'_\gamma) \quad (4)$$

With $\phi = 29°$, enter the chart on page 222 in Terzaghi and Peck (1967) and observe that $N'_\gamma = 5.0$. Therefore,

$$q'_U = 0.4\,(0.61\ g/cm^3)\ (500\ cm)\ (5.0)$$

$$q'_U = 610\ g/cm^2 = 0.610\ kg/cm^2$$

Assume that a factor of safety equal to 1.5 will be adequate. Therefore,

$$q''_U = \frac{q'_U}{F.S.} \quad (5)$$

$$q''_U = \frac{0.610}{1.5} = 0.407\ kg/cm^2$$

If the applied load is less than $0.407\ kg/cm^2$, the sediment will not fail in shear. The above calculations do not consider (1) that any vibration of the sediment mass may cause the sediment to flow, which would result in failure, or (2) the tendency of sands to arch when a load is applied, which would result in the mass supporting a larger load.

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13. ABSTRACT

A preliminary investigation of the surficial sediments at the SEALAB III Test Site shows the textural, compositional, and engineering properties to be uniform in both makeup and distribution. Sands and silty sands are the dominant textural grade. Mean diameters range from 0.09 to 0.25 mm. Carbonate content ranges from 55 to 78 percent. The carbonate is in the form of biogenic calcite. Detrital silicates (feldspars, quartz, illite, and chlorite) and minor amounts of organic matter are the remaining constituents present. Wet unit weights and water contents (percent dry weight) on individual samples range from 1.56 to 1.71 g/cm^3 and from 45 to 77 percent, respectively.

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Laboratory Item 318

A SUMMARY OF SEDIMENT SIZE AND COMPOSITION ANALYSES OF CORES AND GRABS OF SAN CLEMENTE ISLAND; JULY 1967.

Prepared by:
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August 1967

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EXPLANATION OF COMPUTER DATA SHEET
SEDIMENT SIZE AND COMPOSITION

Results of sediment-size and composition core analysis performed by the U. S. Naval Oceanographic Office Geological Laboratory are tabulated on Computer Data Sheet Sediment Size and Composition.

The following is an explanation of the terms employed on the Computer Data Sheet:

1. CRUISE. A number assigned to each cruise for identification purposes.

2. SAMPLE. A consecutive number applied to each core taken successively throughout the cruise.

3. LATITUDE. Expressed in degrees, minutes, and tenth of minutes.

4. LONGITUDE. Expressed in degrees, minutes, and tenths of minutes.

5. TAKEN. Date in day, month, and year that core was taken.

6. CORER TYPE. Number corresponding to sampling device code below.

1. Hydroplastic piston	6. Orange Peel
2. Hydroplastic gravity	7. Ewing
3. Kullenberg piston	8. Vibrocorer
4. Kullenberg gravity	9. Dredge
5. Phleger gravity	0. Other

7. LENGTH. Length of core recorded in centimeters as observed in the laboratory.

8. PENETRATION. Penetration of coring device recorded in centimeters as observed in the field.

9. DEPTH. The uncorrected sonic sounding recorded in meters.

10. ANALYZED. Date in day, month, and year that the core was analyzed in the laboratory.

11. ID. NO. Three digit laboratory project number followed by consecutive number assigned to each subsample analyzed.

12. INTERVAL. Interval of subsample as measured in centimeters from the top of the core.

13. MM. Particle diameter size intervals based on Wentworth size grades in millimeters.

14. PER. Percent of total sample weight within the given size interval. Smallest size analyzed is 0.0010 mm. Percent recorded for 0.0000- is

percentage of particles smaller than 0.0310 mm.

15. GRAVEL, SAND, SILT, CLAY. Percent of total sample weight within the four size classes.

Class ranges are: Gravel - coarser than 2mm
Sand - 2 to 0.0625 mm
Silt - 0.0625 to 0.0039 mm
Clay - finer than 0.0039 mm

16. MEAN (MM). The geometric mean of the distribution expressed in millimeters.

17. MEAN (PHI). The logarithmic mean of the distribution expressed in phi units ($-\log_2$ of the diameter in millimeters).

18. STAN DEV. Standard deviation. A measure of the degree of spread or dispersion of the distribution about the mean expressed in phi units.

$$s = \sqrt{\sum f(X_i - \bar{X})^2/100}$$

19. SKEWNESS. A measure of the asymmetry of the distribution. Positive values denote skewness of the distribution toward the fine particles, negative values denote skewness toward the coarse particles. A normal distribution has a skewness of 0.

$$\text{SKEWNESS} = 1/100\ 2s^{-3} \sum f(X_i - \bar{X})^3$$

20. KURTOSIS. A measure of the peakedness of the distribution. Positive values denote a "leptokurtic" distribution, or a distribution more "peaked" than normal. Negative values denote a "platykurtic" distribution, or a distribution more "flat" than normal. A normal curve has a kurtosis of 0.

$$\text{KURTOSIS} = 1/100\ s^{-4} \sum f(X_i - \bar{X})^4 - 3$$

21. $CaCO_3$. Percent calcium carbonate of the total sample weight as determined by the insoluble residue method.

22. ORG CARBON. Percent organic carbon of the total sample weight as determined by the Allison method.

23. COLOR. Wet sediment color, based on the Geological Society of America Rock-Color Chart, as determined in the laboratory.

24. DOM MINERAL. Dominant mineral (s) comprising the sample assemblage.

25. SEC MINERAL. Secondary mineral (s) comprising the sample assemblage.

SEDIMENT SIZE AND COMPOSITION DATA

CRUISE ROBERT SAMPLE 1 LATITUDE 33 0.1 N LONGITUDE 118 32.1 W TAKEN 07/67
CORER TYPE 4 LENGTH 7.0 PENETRATION 0.0 DEPTH 0.0 ANALYZED 1[illegible]/06/67

ID. NO. 318 1
INTERVAL 0.0- 7.0

MM	PER	PER	PER	PER	PER	PER
4.0000	0.000					
2.0000	0.297					
1.0000	0.890					
0.5000	4.748					
0.2500	19.881					
0.1250	32.047					
0.0625	24.332					
0.0312	10.089					
0.0156	1.187					
0.0078	1.484					
0.0039	0.593					
0.0020	0.890					
0.0010	0.000					
0.0005	0.000					
0.0000-	3.561					
GRAVEL	0.297					
SAND	81.899					
SILT	13.353					
CLAY	4.451					
MEAN (MM)	0.1157					
MEAN (PHI)	3.1113					
STAN DEV	2.1182					
SKEWNESS	1.1311					
KURTOSIS	6.6829					
CACO3	59.000					
ORG CARBON	0.000					
COLOR						
DOM MINERAL						
SEC MINERAL						

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SEDIMENT SIZE AND COMPOSITION DATA

CRUISE ROBEPT SAMPLE 6 LATITUDE 33 0.0 N LONGITUDE 118 32.1 W TAKEN 07/67
CORER TYPE 4 LENGTH 7.0 PENETRATION 0.0 DEPTH 0.0 ANALYZED 1[illegible]/08/67

ID. NO. 318 2
INTERVAL 0.0- 7.0

MM	PER	PER	PER	PER	PER	PER
4.0000	0.000					
2.0000	1.462					
1.0000	4.094					
0.5000	9.357					
0.2500	15.205					
0.1250	17.836					
0.0625	26.316					
0.0312	18.421					
0.0156	1.462					
0.0078	0.585					
0.0039	1.170					
0.0020	0.000					
0.0010	0.292					
0.0005	0.000					
0.0000-	3.801					
GRAVEL	1.462					
SAND	72.807					
SILT	21.637					
CLAY	4.094					
MEAN (MM)	0.1167					
MEAN (PHI)	3.0994					
STAN DEV	2.3472					
SKEWNESS	0.7628					
KURTOSIS	4.1805					
CACO3	67.000					
ORG CARBON	0.000					
COLOR						
DOM MINERAL						
SEC MINERAL						

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SEDIMENT SIZE AND COMPOSITION DATA

CRUISE 8OOEPT SAMPLE 7 LATITUDE 33 0.0 N LONGITUDE 118 32.1 W TAKEN 07/67
CORER TYPE 4 LENGTH 10.0 PENETRATION 0.0 DEPTH 0.0 ANALYZED 1./06/67

ID. NO. 318 3
INTERVAL 0.0- 10.0

MM	PER	PER	PER	PER	PER	PER
4.0000	0.000					
2.0000	0.061					
1.0000	1.211					
0.5000	8.177					
0.2500	12.720					
0.1250	24.833					
0.0625	26.651					
0.0312	20.291					
0.0156	0.000					
0.0078	0.909					
0.0039	0.909					
0.0020	0.000					
0.0010	0.909					
0.0005	0.000					
0.0000-	3.331					

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GRAVEL	0.061
SAND	73.592
SILT	22.108
CLAY	4.240
MEAN (MM)	0.1024
MEAN (PHI)	3.2880
STAN DEV	2.1322
SKEWNESS	0.9611
KURTOSIS	5.6292
CACO3	64.000
ORG CARBON	0.000
COLOR	
DOM MINERAL	
SEC MINERAL	

SEDIMENT SIZE AND COMPOSITION DATA

CRUISE RDDEPT SAMPLE 8 LATITUDE 33 0.0 N LONGITUDE 118 32.2 W TAKEN 07/67
CORER TYPE 4 LENGTH 7.0 PENETRATION 0.0 DEPTH 0.0 ANALYZED 10/30/67

ID. NO. 318 4
INTERVAL 0.0- 7.0

MM	PER	PER	PER	PER	PER	PER
4.0000	0.000					
2.0000	2.414					
1.0000	6.207					
0.5000	5.172					
0.2500	9.655					
0.1250	17.931					
0.0625	27.931					
0.0312	23.103					
0.0156	0.000					
0.0078	1.379					
0.0039	0.000					
0.0020	0.000					
0.0010	2.069					
0.0005	0.000					
0.0000-	4.138					
GRAVEL	2.414					
SAND	66.897					
SILT	24.483					
CLAY	6.207					
MEAN (MM)	0.0994					
MEAN (PHI)	3.3310					
STAN DEV	2.5194					
SKEWNESS	0.4354					
KURTOSIS	3.0735					
CACO3	72.000					
ORG CARBON	0.000					
COLOR						
DOM MINERAL						
SEC MINERAL						

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SEDIMENT SIZE AND COMPOSITION DATA

CRUISE ROBERT SAMPLE 9 LATITUDE 32 1.9 N LONGITUDE 118 32.3 W TAKEN 07/67
CORER TYPE 4 LENGTH 4.0 PENETRATION 0.0 DEPTH 0.0 ANALYZED 1 /08/67

ID. NO. 318 5
INTERVAL 0.0- 4.0

MM	PER	PER	PER	PER	PER	PER
4.0000	2.469					
2.0000	2.469					
1.0000	13.169					
0.5000	18.107					
0.2500	15.226					
0.1250	19.342					
0.0625	12.757					
0.0312	12.346					
0.0156	0.412					
0.0078	0.823					
0.0039	0.000					
0.0020	0.823					
0.0010	0.000					
0.0005	0.000					
0.0000-	2.058					
GRAVEL	4.938					
SAND	78.601					
SILT	13.580					
CLAY	2.881					
MEAN (MM)	0.2461					
MEAN (PHI)	2.0226					
STAN DEV	2.3663					
SKEWNESS	0.6720					
KURTOSIS	3.4513					
CACO3	69.000					
ORG CARBON	0.000					
COLOR						
DOM MINERAL						
SEC MINERAL						

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SEDIMENT SIZE AND COMPOSITION DATA

CRUISE RODGERS SAMPLE 10 LATITUDE 33 1.9 N LONGITUDE 119 32.2 W TAKEN 07/67
CORER TYPE 4 LENGTH 10.0 PENETRATION 0.0 DEPTH 0.0 ANALYZED 10/30/67

ID. NO. 318 6
INTERVAL 0.0- 10.0

MM	PER	PER	PER	PER	PER	PER
4.0000	0.000					
2.0000	0.733					
1.0000	3.663					
0.5000	9.158					
0.2500	10.256					
0.1250	19.048					
0.0625	26.374					
0.0312	20.513					
0.0156	1.465					
0.0078	0.733					
0.0039	0.733					
0.0020	0.733					
0.0010	2.198					
0.0005	0.000					
0.0000-	4.396					
GRAVEL	0.733					
SAND	68.498					
SILT	23.443					
CLAY	7.326					
MEAN (MM)	0.0914					
MEAN (PHI)	3.4524					
STAN DEV	2.5350					
SKEWNESS	0.7179					
KURTOSIS	2.8785					
CACO3	67.000					
ORG CARBON	0.000					
COLOR						
DOM MINERAL						
SEC MINERAL						

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SEDIMENT SIZE AND COMPOSITION DATA

CRUISE ROBERT SAMPLE 11 LATITUDE 33 0.1 N LONGITUDE 118 32.1 W TAKEN 07/67
CORER TYPE 4 LENGTH 5.0 PENETRATION 0.0 DEPTH 0.0 ANALYZED 1 /[illegible]/67

ID. NO. 318 7
INTERVAL 0.0- 5.0

MM	PER	PER	PER	PER	PER	PER
4.0000	1.356					
2.0000	1.356					
1.0000	5.763					
0.5000	6.441					
0.2500	9.831					
0.1250	13.220					
0.0625	20.678					
0.0312	30.847					
0.0156	1.356					
0.0078	0.339					
0.0039	0.339					
0.0020	0.678					
0.0010	3.390					
0.0005	0.000					
0.0000-	4.407					
GRAVEL	2.712					
SAND	55.932					
SILT	32.881					
CLAY	8.475					
MEAN (MM)	0.0855					
MEAN (PHI)	3.5479					
STAN DEV	2.7404					
SKEWNESS	0.4847					
KURTOSIS	1.7302					
CACO3	55.000					
ORG CARBON	0.000					
COLOR						
DOM MINERAL						
SEC MINERAL						

SEDIMENT SIZE AND COMPOSITION DATA

CRUISE RODEPT SAMPLE 12 LATITUDE 33 0.0 N LONGITUDE 118 32.1 W TAKEN 07/67
CORER TYPE 4 LENGTH 9.0 PENETRATION 0.0 DEPTH 0.0 ANALYZED 1[illegible]/08/67

ID. NO. 318 8
INTERVAL 0.0- 9.0

MM	PER	PER	PER	PER	PER	PER
4.0000	0.000					
2.0000	0.562					
1.0000	3.652					
0.5000	8.708					
0.2500	15.449					
0.1250	20.787					
0.0625	22.753					
0.0312	23.315					
0.0156	0.281					
0.0078	0.562					
0.0039	0.281					
0.0020	0.562					
0.0010	0.000					
0.0005	0.000					
0.0000-	3.090					
GRAVEL	0.562					
SAND	71.348					
SILT	24.438					
CLAY	3.652					
MEAN (MM)	0.1174					
MEAN (PHI)	3.0899					
STAN DEV	2.1503					
SKEWNESS	0.8086					
KURTOSIS	5.1916					
CACO3	74.000					
ORG CARBON	0.000					
COLOR						
DOM MINERAL						
SEC MINERAL						

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SEDIMENT SIZE AND COMPOSITION DATA

CRUISE RODGERT SAMPLE 36 LATITUDE 33 0.2 N LONGITUDE 118 32.1 W TAKEN 07/67
CORER TYPE 6 LENGTH 0.0 PENETRATION 0.0 DEPTH 0.0 ANALYZED 14/38/67

ID. NO. 318 9
INTERVAL 0.0- 0.0

MM	PER	PER	PER	PER	PER	PER	PER
4.0000	0.906						
2.0000	0.604						
1.0000	3.927						
0.5000	8.459						
0.2500	18.731						
0.1250	35.233						
0.0625	19.335						
0.0312	10.272						
0.0156	0.000						
0.0078	0.302						
0.0039	0.000						
0.0020	0.302						
0.0010	0.604						
0.0005	0.000						
0.0000-	3.323						
GRAVEL	1.511						
SAND	83.686						
SILT	10.574						
CLAY	4.230						
MEAN (MM)	0.1511						
MEAN (PHI)	2.7266						
STAN DEV	2.2137						
SKEWNESS	1.0005						
KURTOSIS	6.4315						
CACO3	66.000						
ORG CARBON	0.000						
COLOR							
DOM MINERAL							
SEC MINERAL							

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SEDIMENT SIZE AND COMPOSITION DATA

CRUISE RDDEPT SAMPLE 4D LATITUDE 33 0.1 N LONGITUDE 118 32.0 W TAKEN 07/67
CORER TYPE 6 LENGTH 0.0 PENETRATION 0.0 DEPTH 0.0 ANALYZED 14/08/67

ID. NO. 318 10
INTERVAL 0.0- 0.0

MM	PER	PER	PER	PER	PER	PER
4.0000	0.000					
2.0000	0.063					
1.0000	0.943					
0.5000	4.085					
0.2500	17.599					
0.1250	23.256					
0.0625	31.741					
0.0312	14.771					
0.0156	1.571					
0.0078	0.943					
0.0039	0.314					
0.0020	0.629					
0.0010	0.943					
0.0005	0.000					
0.0000-	3.143					
GRAVEL	0.063					
SAND	77.624					
SILT	17.599					
CLAY	4.714					
MEAN (MM)	0.1007					
MEAN (PHI)	3.3114					
STAN DEV	2.0709					
SKEWNESS	1.0502					
KURTOSIS	6.1915					
CACO3	69.000					
ORG CARBON	0.000					
COLOR						
DOM MINERAL						
SEC MINERAL						

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SEDIMENT SIZE AND COMPOSITION DATA

CRUISE RODEPT SAMPLE 5E LATITUDE 33 0.1 N LONGITUDE 118 31.9 W TAKEN 07/67
CORER TYPE 6 LENGTH 0.0 PENETRATION 0.0 DEPTH 0.0 ANALYZED 14/08/67

ID. NO. 318 11
INTERVAL 0.0- 0.0

MM	PER	PER	PER	PER	PER	PER
4.0000	0.000					
2.0000	0.824					
1.0000	4.396					
0.5000	6.593					
0.2500	12.637					
0.1250	35.165					
0.0625	21.703					
0.0312	11.538					
0.0156	1.648					
0.0078	1.374					
0.0039	0.000					
0.0020	1.374					
0.0010	0.000					
0.0005	0.000					
0.0000-	2.747					
GRAVEL	0.824					
SAND	80.495					
SILT	14.560					
CLAY	4.121					
MEAN (MM)	0.1286					
MEAN (PHI)	2.9588					
STAN DEV	2.1151					
SKEWNESS	0.8952					
KURTOSIS	5.7161					
CACO3	72.000					
ORG CARBON	0.000					
COLOR						
DOM MINERAL						
SEC MINERAL						

SEDIMENT SIZE AND COMPOSITION DATA

CRUISE ROBERT SAMPLE 6P LATITUDE 33 1.9 N LONGITUDE 118 31.9 W TAKEN 07/67
CORER TYPE 6 LENGTH 0.0 PENETRATION 0.0 DEPTH 0.0 ANALYZED 14/08/67

ID. NO. 318 13
INTERVAL 0.0- 0.0

MM	PER	PER	PER	PER	PER	PER
4.0000	2.486					
2.0000	1.657					
1.0000	2.762					
0.5000	4.972					
0.2500	9.116					
0.1250	18.785					
0.0625	32.873					
0.0312	20.442					
0.0156	0.829					
0.0078	0.276					
0.0039	1.934					
0.0020	0.552					
0.0010	0.000					
0.0005	0.000					
0.0000-	3.315					
GRAVEL	4.146					
SAND	68.508					
SILT	23.481					
CLAY	3.867					
MEAN (MM)	0.1060					
MEAN (PHI)	3.2376					
STAN DEV	2.3482					
SKEWNESS	0.5032					
KURTOSIS	3.5427					
CACO3	67.000					
ORG CARBON	0.000					
COLOR						
DOM MINERAL						
SEC MINERAL						

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SEDIMENT SIZE AND COMPOSITION DATA

CRUISE ROBERT SAMPLE 90 LATITUDE 33 1.9 N LONGITUDE 118 32.1 W TAKEN 07/67
CORER TYPE 6 LENGTH 0.0 PENETRATION 0.0 DEPTH 0.0 ANALYZED 14/08/67

ID. NO. 318 12
INTERVAL 0.0- 0.0

NM	PER	PER	PER	PER	PER	PER
4.0000	0.000					
2.0000	2.622					
1.0000	10.861					
0.5000	25.094					
0.2500	14.981					
0.1250	10.861					
0.0625	14.607					
0.0312	10.487					
0.0156	4.120					
0.0078	0.749					
0.0039	1.124					
0.0020	0.000					
0.0010	0.000					
0.0005	0.000					
0.0000-	4.494					
GRAVEL	2.622					
SAND	76.404					
SILT	16.479					
CLAY	4.494					
MEAN (MM)	0.1911					
MEAN (PHI)	2.3876					
STAN DEV	2.7414					
SKEWNESS	0.7940					
KURTOSIS	3.0328					
CACO3	78.000					
ORG CARBON	0.000					
COLOR						
DOM MINERAL						
SEC MINERAL						

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